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A new night lizard (*Xantusia henshawi*) from a sandstone habitat in San Diego County, California

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Abstract. A new subspecies of night lizard, *Xantusia henshawi,* is described and differentiated from *X. h. henshawi* and *X. h. bolsonae* based on the presence of an enlarged temporal scale, absence of enlarged auriculars, a narrower head and body, significantly fewer scales around the upper portions of the hindlimbs, no black peppering on the ventral surfaces of the limbs, a reduced dorsal pattern consisting of small round spots, no marked light and dark diel color phase, weakly defined vertebral furrow, and less scansorial habits.

Introduction

The geographical distribution of the Night Lizard genus *Xantusia* is notable for its numerous isolated populations (Webb 1965, 1970, Smith and Brodie 1982). Collectively, these populations comprise three species (Bezy 1972) ranging from northern Mexico and southwestern United States to the Channel Islands of California. In spite of this fragmented distribution, many populations are morphologically quite uniform within a species, yet the distinctiveness between others has promoted the recognition of several subspecies (Savage 1952, Webb 1965, 1970, Bezy 1967*a, b*). We report here on another isolated population, one confined to a sandstone habitat in San Diego County, California, and sufficiently distinct morphologically, biochemically, behaviorally, and in color pattern to warrent subspecific recognition within *X. henshawi.* Scale terminology follows Savage (1963) except where noted. All measurements and counts are taken from preserved specimens.

Xantusia henshawi gracilis new subspecies
Figure 1a

Suggested common name.—Sandstone night lizard.

Holotype.—SDSNH 64830, adult male collected by L. L. Grismer and M. A. Galvan on 17 February 1985 from the Truckhaven Rocks in the Anza-Borrego Desert State Park, located 24.5 km east and 6.3 km north of Borrego Springs, San Diego County, California.

Paratypes.—Collected by authors at same locale as holotype. LACM 132488, 4 April 1978; SDSNH 64824, 31 December 1979; SDSNH 64814–23, 1 December 1984; SDSNH 64804–11, 8 December 1984; SDSNH 64812–13, 9 December 1984; SDSNH 64825–29, 17 February 1985.

Diagnosis.—*Xantusia henshawi gracilis* differs from *X. h. henshawi* and *X. h. bolsonae* by having a greatly enlarged temporal scale equal to nearly one-half the size of the postparietal; absence of enlarged auriculars; absence of a vertebral furrow (in

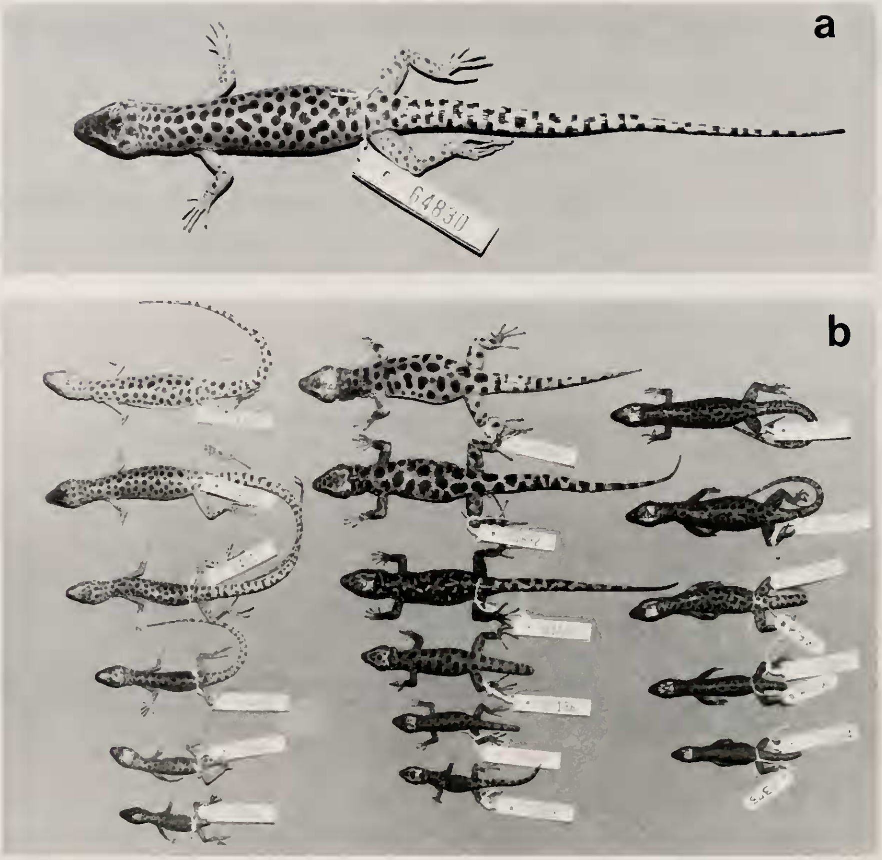

FIGURE 1. a) Holotype of *Xantusia henshawi gracilis.* b) Left row *X. h. gracilis,* middle row *X. h. henshawi,* right row *X. h. bolsonae.*

life); significantly different morphometric ratios concerning head depth/head width and interforelimb distance (Table 1); the lack of marked light and dark diel color phases; the almost complete absence of black peppering on all ventral surfaces; a reduced dorsal body pattern consisting primarily of small uniform round spots; and at least four fixed allelic differences out of 22 presumptive gene loci (Bezy and Sites 1986). *Xantusia h. gracilis* is significantly differentiated further from *X. h. henshawi* by having fewer scales around the upper arm and leg, higher number of supralabials, fewer longitudinal rows of dorsal scales, and a smaller interhindlimb distance/SVL (Table 1). *Xantusia h. gracilis* is significantly differentiated further from *X. h. bolsonae* by having a higher number of gular scales, fewer enlarged scales on pregular fold, a higher number of temporal scales, dorsal scales, and femoral pores (Table 1).

Description of holotype.—Adult male SVL 59.6 mm; see Table 2 for other measurements; head triangular, slightly wider than neck; nostrils visible in dorsal view; eye large, closer to nostril than ear opening; ear opening elliptical, twice as high as wide, long axis directed anteroventrally; anterior pregular fold ventral to ear opening indicated by transverse row of reduced scales medially; posterior pregular fold six scale rows anterior to gular fold; gular fold indicated by large rectangular scales on edge, increasing in size medially and abruptly differentiated from scales on fold posteriorly; digits of pes and manus overlapping when limbs adpressed.

Rostral slightly broader than high, with pointed dorsoposterior margin, followed in order by two nasals, a hexagonal frontoparietal, two prefrontals, a median, two frontals, a hexagonal interparietal separating two parietals, and two large postparietals; interparietal with conspicuous eye spot in posterior one-third; postparietals separated posteriorly by two small triangular interpostparietals that touch nuchals; nasals, pre-

TABLE 1. Range, means ($\bar{x}$), and standard deviation (SD) for eleven meristic and three morphometric ratios of *Xantusia henshawi bolsonae* ($n = 22$), *X. h. gracilis* ($n = 28$), and *X. h. henshawi* ($n = 139$). Characters followed by an asterisk denote significantly different means between *X. h. gracilis* and *X. h. henshawi* based on a Student's t-test at a confidence level of 95%.

	Bolsonae			*Gracilis*			*Henshawi*		
	Range	$\bar{x}$	±SD	Range	$\bar{x}$	±SD	Range	$\bar{x}$	±SD
Supralabials*	6–8	6.8	0.04	6–8	7.1	0.03	5–8	6.2	0.04
Infralabials	5–6	5.3	0.07	5–8	5.5	0.04	4–6	5.1	0.06
Gulars	34–41	38.2	3.11	40–48	43.3	4.79	33–49	41.7	5.41
Enlarged scales on gular fold*	10–14	12.0	0.88	7–11	8.9	6.17	7–14	10.3	0.29
Temporals	5–7	6.2	0.04	7–10	8.0	0.09	6–11	8.2	0.11
Dorsals*	47–55	49.4	4.74	53–64	57.6	5.11	56–71	62.8	4.83
Scales around upper arm*	17–22	18.8	0.12	16–25	20.1	0.23	20–29	24.7	0.16
Scales around upper leg*	27–32	28.7	0.38	23–30	26.6	0.21	28–38	32.4	0.20
Femoral pores	11–14	12.5	0.03	17–22	18.4	0.09	12–30	19.5	2.41
Transverse ventrals	31–34	32.1	0.15	30–34	31.7	0.87	30–36	32.7	1.57
4th toe lamellae	23–26	24.2	0.91	21–30	25.3	2.91	19–29	24.4	3.21
Head depth/head width*#	40.3%–59.6%	48.4%	4.01	55.0%–72.0%	61.0%	5.78	40.1%–58.7%	52.1%	5.11
Interforelimb distance/SVL*	13.0%–19.0%	15.2%	2.73	10.2%–14.3%	12.1%	0.08	13.0%–21.2%	15.3%	3.17
Interhindlimb distance/SVL*	10.4%–12.8%	11.4%	0.09	9.2%–11.9%	10.7%	0.05	9.8%–14.9%	12.5%	0.87

When plotted as a function of snout–vent length, slopes not significantly different from each other or zero based on a student t-test at a 95% confidence level. Thus, no allometric biasing present in sample.

TABLE 2. Selected measurements (mm) of holotype SDSNH 64830.

Tail length	82.2
Head length (tip of snout to anterior of ear opening)	12.7
Maximal head width anterior to ear opening	9.5
Maximal head depth anterior to ear opening	5.7
Tip of snout to posterior margin of postparietal	13.3
Diameter of eye	3.0
Anterior of eye to tip of snout	5.4
Tip of snout to gular fold	19.6
Length of right leg (insertion to tip of 4th toe)	27.1
Length of 4th toe	7.0
Length of right arm (insertion to tip of 4th finger)	19.7
Length of 4th finger	4.8
Axilla-groin length	27.9
Interforelimb distance	8.0
Interhindlimb distance	6.4

frontals, frontals, and postparietals in contact at midline; enlarged scales of head pitted throughout; nostril elliptical, bordering rostral, first supralabial, nasal, and postnasal, followed in order by postnasal, anterior loreal, loreal, and two loreolabials (dorsal loreolabial smaller), and small preocular scales of ocular ring; scales of ocular ring small, two postoculars largest; uppermost postocular touching fifth supraocular; five supraoculars, third and fourth on left side with slightly damaged lateral margins; temporals nine (R) nine (L) (Fig. 4). Supralabials seven (R) eight (L); infralabials six (R) six (L); pretympanic scales decreasing in size ventrally; auricular scales slightly enlarged dorsally; mental longer than broad; three large pairs of postmentals, first pair contacting medially; anteriormost four rows of gular scales largest; 43 transverse rows of gular scales (includes all scale rows between gular fold and first pair of postmentals), 20 rows between anterior postmental and anterior pregular fold, 17 rows between anterior and posterior pregular folds, and 6 rows between gular fold and posterior pregular fold, curving to the anteromedially; 10 enlarged rectangular scales on gular fold, increasing in size medially; five rows of small scales in gular fold, anterior row smallest.

Back, sides, and limbs covered with granular scales; some brachials and femorals slightly enlarged; 19 (R) 22 (L) scales around upper arm and 27 (R) 27 (L) scales around upper leg; 14 longitudinal rows of rectangular ventrals at midbody, two bordering midline slightly narrower, lateralmost with curved lateral margins and slightly narrower adjacent ventrals; 30 transverse rows of ventral scales; one pair of enlarged preanal scales bordered posteriorly by six small precloacal scales, laterally by two larger scales, and anteriorly by three larger scales; 54 longitudinal rows of dorsal scales at midbody; 130 transverse rows of middorsal scales from postparietals to posterior margin of hindlimb insertion; vertebral furrow of dorsum slightly evident in sacral region; 25 (R) 24 (L) lamellae on fourth toe; nine femoral pores on each hindlimb; caudal scales rectangular roughly twice as wide ventrally as dorsally.

Coloration of holotype in life.—Dorsal ground color of head, body, hindlimbs, and distal portion of forelimbs yellow to white; interorbital region bluish; ground color of all dorsal surfaces much more extensive than dorsal markings; proximal region of forelimbs white to pinkish; sides of body white; all ventral surfaces white with minute amounts of black peppering present only on lateral gular and ventral scales, pes, manus, and forelimbs; dorsal body pattern consisting of dark brown, small round spots; head plates anterior to parietals covered moderately with black peppering producing poorly defined blotches, largest posteriorly; small dark brown markings on dorsal surfaces of limbs present except on proximal portion of forelimbs; dark markings on side of head, neck, and body paler, and smaller than those dorsally; labial scales moderately punctate with black peppering; dark brown markings on tail confined to groups of scales, producing squarish markings; some scales of tail with black peppering, others immaculate.

Variation.—The paratypes approximate the holotype in general morphology. Most variation occurs in the presence of intercalary scales between some of the large dorsal head plates and, in some cases, their fusion to the anterior supraocular scales. In SDSNH 64804 the frontoparietal is divided. In SDSNH 64811 the left parietal is divided into two larger lateral scales and one smaller medial scale, and the right parietal is incompletely divided. The right parietal is also completely divided in SDSNH 64822. In SDSNH 64808–09, 64815, 64818–20, 64822, 64826, and 64829 the temporals bordering the lateral margin of the postparietal are two to three times larger than those of other specimens. SDSNH 64816 has one interpostparietal. In SDSNH 64810 there is one slightly enlarged auricular dorsally and two in SDSNH 64811. In SDSNH 64808 the third postmental on the left side reaches the lip and separates the third and fourth infralabials. The single pair of enlarged preanal scales in SDSNH 64809 is bordered anteriorly by three smaller scales. SDSNH 64807, 64811, 64817, 64819, and 64827–28 have two pairs of enlarged preanal scales and, with the exception of SDSNH 64807, have a small intercalary scale at their center, contacting all of them. In SDSNH 64808 and 64820 there are three pairs of enlarged preanal scales.

Generally, the paratypes approximate the holotype in basic features of coloration and pattern. The major difference is in LACM 132488, which almost entirely lacks dorsal spots and has a uniform tan-white ground color overlaid with a yellow reticulum (in life). IN SDSNH 64829 the dorsal spots are reduced and intermediate between LACM 132488 and the remaining paratypes. The dorsal body markings of SDSNH 64804, 64815, 64818, 64821, 64827–28 are more irregular and slightly larger. There appears to be a slight ontogenetic change in dorsal body blotching, with markings becoming more rounded and better defined in larger specimens (Fig. 1b). The ventral peppering of most paratypes is slightly less concentrated than that of the holtoype, manifesting itself in SDSNH 64813, 64827, 64829, and LACM 132488 which have almost a complete absence of black peppering on the ventral surfaces.

The smallest two individuals are SDSNH 64806 and 64814 at 30.5 mm SVL and 30.7 mm SVL, respectively, and the largest two individuals are SDSNH 64804 and 64812 at 70.5 mm SVL and 70.8 mm SVL, respectively. Adult males have larger, better developed femoral pores than females and show a slight swelling posterior to the vent.

Etymology.—The adjectival name *gracilis,* meaning slender, comes from the Latin root *gracil,* and pertains to this population's slender habitus.

Comparisons with other subspecies.—A total of 139 specimens of *Xantusia henshawi henshawi* from the eastern most portion of its range in Riverside, San Diego, and Imperial Counties was examined. These specimens showed major geographic variation in numbers of femoral pores and temporal scales. Specimens from Riverside County had an average of 23.8 (18–30) femoral pores (count includes both legs) and an average temporal scale count of 7.9 (7–11). Those of San Diego and Imperial Counties had combined averages of 17.4 (12–22) femoral pores and 8.4 (6–11) temporals. Webb (1970) also noted a similar cline in these counts for *X. h. henshawi.* A total of 19 *X. h. bolsonae* was examined and showed no noteworthy intrapopulational variation.

Xantusia henshawi gracilis is more terrestrial and less scansorial than other subspecies of *X. henshawi* (*see* below) being less of an obligate exfoliation-dwelling lizard. Presumably, this is reflected in its narrower head (greater head depth/head width ratio [Table 1]), body (smaller interlimb distances [Fig. 2a] and significantly fewer dorsal scales at midbody [Table 1]), and thinner limbs (significantly fewer rows of scales around their proximal portions [Table 1]) (Fig. 3). The interlimb distances and average limb growth rates seem to be reliable diagnostic characters for *X. h. gracilis,* although determining the point of limb insertion on the body is somewhat arbitrary, which is probably reflected in the wide range of measurements (Table 1).

Neonate, juvenile, and subadult *Xantusia henshawi gracilis* have longer limbs than comparably-sized *X. h. henshawi.* The limbs of *X. h. henshawi,* however, grow significantly faster, so that at snout–vent lengths of 60 mm to 70 mm their limb length/SVL

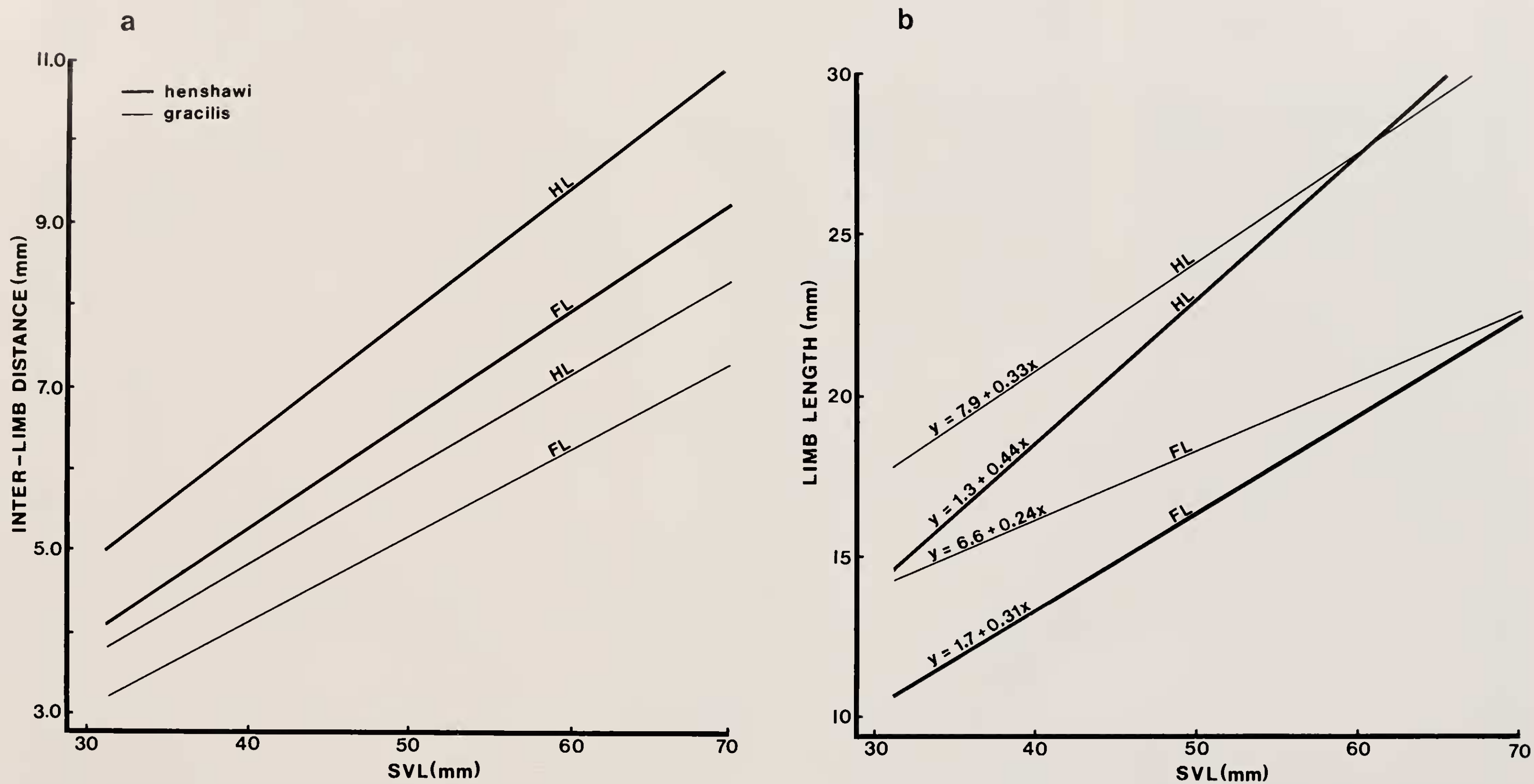

FIGURE 2. a) Linear regressions for interlimb distances of *Xantusia henshawi henshawi* and *X. h. gracilis*. $r = 0.827$ and 0.807 for HL of *X. h. gracilis* and *X. h. henshawi*, respectively. $r = 0.771$ and 0.818 for FL of *X. h. gracilis* and *X. h. henshawi* respectively. b) Average limb growth rate vs. SVL for *X. h. henshawi* and *X. h. gracilis*. Slopes significantly different between *X. h. henshawi* and *X. h. gracilis*; $t = 1.04$ for forelimbs and 1.13 for hindlimbs at a 95% confidence level. $r = 0.938$ and 0.948 for HL of *X. h. gracilis* and *X. h. henshawi* respectively. $r = 0.901$ and 0.892 for FL of *X. h. gracilis* and *X. h. henshawi* respectively. FL = forelimb and HL = hindlimb.

FIGURE 3. Top. Adult *Xantusia henshawi henshawi* from Ranchita, San Diego County, California. Bottom. Adult *X. h. gracilis* from Truckhaven Rocks, San Diego County, California.

ratios approach those of *X. h. gracilis* (Fig. 2b). The hindlimbs of *X. h. bolsonae* are relatively shorter than the hindlimbs of *X. h. gracilis* and *X. h. henshawi,* whereas their forelimbs are longer.

Xantusia henshawi gracilis has a greatly enlarged temporal scale that is nearly one-half the size of the postparietal. That of *X. h. henshawi* is also enlarged, but equals less than one-quarter the size of the postparietal (Fig. 4). The temporal scale in *X. h. bolsonae* is much smaller and only slightly enlarged in some specimens. This is a particularly useful character for diagnosing *X. h. gracilis* because it does not vary, whereas other head scales do so considerably (*see* variation of paratypes for *X. h. gracilis*).

Field and laboratory observations indicate that *Xantusia henshawi gracilis* does not exhibit marked light and dark diel color phases that are common in *X. h. henshawi* (Atsatt 1939). Compared with *X. h. henshawi,* they appear to remain in the light phase, which is further accentuated by the reduction of dark dorsal markings to small, round spots, rather than large, irregular blotches (Fig. 1). In one specimen (LACM 132488), the dorsal markings are almost absent. Some *X. h. henshawi* from Imperial County approach the color pattern of *X. h. gracilis* when in their light phase, but differ in having much larger dorsal markings (*see* top two specimens of middle row in Fig. 1b). The ventral coloring of *X. h. gracilis* is for the most part immaculate, there being only a slight amount of black peppering on the limb and lateral gular surfaces in some specimens. *Xantusia h. henshawi,* on the other hand has extensive peppering on the ventral surface of the head, body, limbs, and tail. The ventral markings of *X. h. bolsonae* are less extensive than those of *X. h. henshawi* on the head and body but nearly equal on the limbs and tail.

Biochemical comparisons.—A preliminary allozyme analysis suggests that *Xantusia henshawi henshawi* and *X. h. gracilis* are sister taxa, based on the presence of three unique alleles; two of these are unique among xantusiids and one is unique among *Xantusia* (Bezy and Sites 1986). The data also demonstrate that *X. h. gracilis* and *X. h. henshawi* are separated by a genetic distance of 0.188 with four fixed allelic differences out of 22 presumptive gene loci. The level of allozyme divergence is comparable to

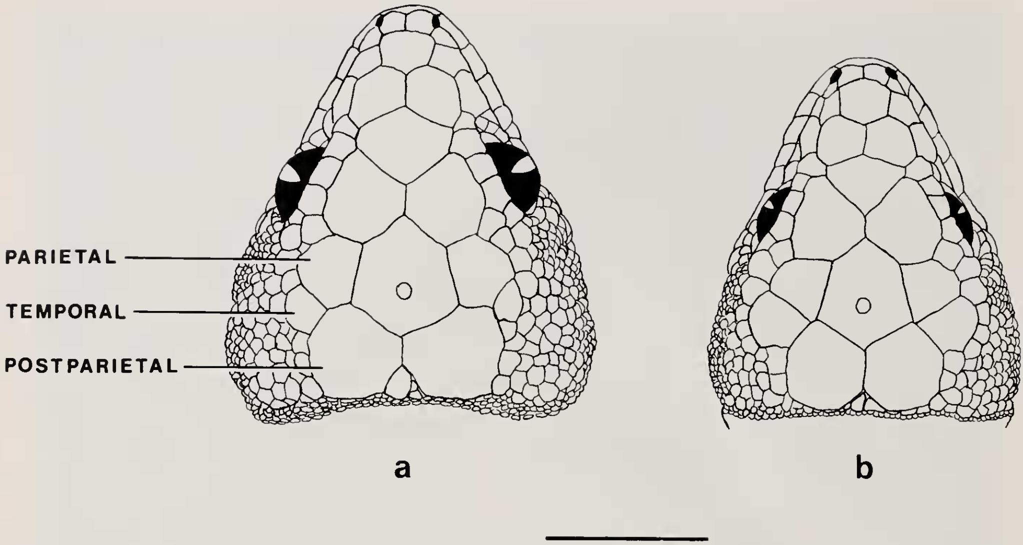

FIGURE 4. Heads of *Xantusia henshawi henshawi* and *X. h. gracilis* demonstrating difference in size of temporal scale. a) *Xantusia h. henshawi* SDSNH 57395, SVL = 65.7 mm. b) Holotype of *X. h. gracilis* SDSNH 64830, SVL = 59.6 mm. Scale equals 5 mm.

that between several subspecies of *X. vigilis. Xantusia h. bolsonae* appears to be most closely related to the sympatric *X. v. extorris* (Webb 1965) and should probably be considered as a separate species (Bezy and Sites 1986). *Xantusia h. gracilis* also appears to differ from *X. h. henshawi* in the expression of certain lactate dehydrogenase enzymes (Sites et al. 1986).

Traditionally, the rank of subspecies has accounted for geographic variation observed in peripherially located, interbreeding parapatric populations. Where allopatry is the case, such as in *Xantusia henshawi henshawi* and *X. h. gracilis,* intergradation is not possible and other criteria must be employed. Since the morphological and biochemical data suggest that these two populations are sister groups, and their level of divergence is similar to that between several subspecies of *X. vigilis* (Savage 1952, Webb 1965, Bezy 1967*a, b*, Bezy and Sites 1986, Sites et al. 1986), we elect to place *gracilis* in *X. henshawi.*

Behavioral observations.—Four specimens of *Xantusia henshawi gracilis* (SDSNH 64823, 64826–28) were maintained alive for a period of two weeks at room temperature in a 9.7 liter glass terrarium. Pieces of sandstone were placed in the terrarium to provide retreats. Five specimens of *Xantusia h. henshawi* were maintained under identical conditions in a separate terrarium, except they were provided with granitic flakes. Both terraria were kept side by side and observed at least once a night for a minimum of thirty minutes between 18:00 and 23:00 hours. A 25 watt red light bulb was suspended approximately one meter above the terraria to provide illumination for observation.

All specimens of *Xantusia henshawi gracilis* were always abroad at night during the observation periods, and on several occasions were observed digging at the bases of the rocks placed on the substrate. Subsequently, they would place their head into the hole, withdraw it, and repeat the process at a different spot beside the same or different rock.

The *Xantusia henshawi henshawi* spent most of their time concealed (only two specimens observed on four of 14 observation periods) and, when abroad, remained on the granite flakes. Conversely, *X. h. gracilis* spent roughly as much time on the substrate moving about the enclosure as on the sandstone.

In another 9.7 liter glass terrarium three *Xantusia henshawi gracilis,* four *X. h. henshawi,* and four *Phyllodactylus xanti* were kept together. On 13 May 1986, two

FIGURE 5. a) Southern view of Truckhaven Rocks, San Diego County, California. b) Slabs of exfoliating sandstone. c) Rodent burrows in sandstone.

clutches of two eggs each of *P. xanti* were observed on a horizontal piece of sandstone. One of the *X. h. gracilis* approached an egg, grasped the end of it in its mouth, and began pulling on it while trying to walk backwards. Consequently, the end of the egg broke off and the lizard ate the part of the shell that remained in its mouth. It then placed its head inside the egg and began lapping up the yolk. When the two other *X. h. gracilis* approached the eggs they were chased away by the lizard that was eating. One of these other lizards then went to an undisturbed egg and repeated the process of breaking it open as described above. Combat between all three *X. h. gracilis* followed with various individuals having dominance over the others until eventually the yolk of all four eggs had been devoured. Following this, they all shared equally in eating the remaining empty shell cases. Interestingly, none of the *X. h. henshawi* showed any interest in the eggs even though they had equal access to them.

The fact that all three *Xantusia henshawi gracilis* were eating and fighting over the eggs, and that they all broke and devoured the eggs in the same manner, suggests that this behavior is not a chance event induced by captivity, but a part of their behavioral repertoire. Conceivably, this was why we were unable to find but one *Phyllodactylus xanti* in the Truckhaven Rocks although in the peripheral regions where *X. henshawi* is presumably absent, *P. xanti* seemed to be in unusual abundance (*see* below).

Habitat and distribution.—Xantusia henshawi gracilis is found within the boundaries of the Anza-Borrego Desert State Park in a small circumscribed region known as the Truckhaven Rocks, approximately 240 m to 305 m elevation. This area is part of the southeastern flank of the Santa Rosa Mountains in northeast San Diego County. It is roughly 3 km long east to west and 1.3 km wide north to south. The Truckhaven Rocks have a complex and as yet unresolved geomorphological history. The region is composed of sandstone and siltstone sediments (Hoover 1965) of unknown age, and it is not certain if its emergence was concomitant with the uplift of the Santa Rosa Mountains (Threet 1974), or the result of an eastward strike-slip displacement along the San Jacinto fault (Sharp 1972). In either case, the sandstone has subsequently undergone tremendous erosion (Fig. 5a) resulting in several arroyos 30 m to 60 m deep, running northwest to southeast.

Xantusia henshawi gracilis is the only known xantusiid from a sandstone habitat. Compared to other *Xantusia henshawi,* its relatively slender physique presumably allows it to exploit the wide range of microhabitats produced by the eroding substrate, as opposed to being restricted to exfoliating microhabitats even though these are also present (Fig. 5b). Some specimens were unearthed in what appeared to be rodent burrows atop piles of hardened siltstone (Fig. 5c). Also, the reduced dorsal markings and lightened color pattern appears more cryptic on the tan-colored sandstone.

Specimens were collected at both the western and eastern extremes of the habitat, but within this region *Xantusia henshawi gracilis* seems to be more abundant in localized areas and not evenly distributed.

The nearest reported locality for *X. h. henshawi* is approximately 38 km to the southwest from Oak Grove (Lee 1976, Julian Lee, *personal communication* 1985). We report two additional specimens from Borrego-Palm Canyon (SDSNH 39426 and 41090), reducing this distance to 32 km. According to Lee (1976), *X. h. henshawi* is found on both the coastal and desert slopes of the Santa Rosa Mountains. The Santa Rosa Mountains, however, run northwest to southeast and have no coastal slope; his locality data show specimens to be present in only the extreme northwest portion. We searched all arroyos on the south facing side of the Santa Rosa Mountains between the Truckhaven Rocks and the nearest reported *X. h. henshawi* locality, as well as those accessible arroyos on the northeastern side. Although the habitat appeared suitable in some places for *X. h. henshawi,* none was found. There did, however, seem to be an unusual abundance of *Phyllodactylus xanti.*

Material examined.—Xantusia henshawi bolsonae LACM 5595-64, 72324–25, 76156–59, 106803–06, 116260–61. *Xantusia henshawi gracilis* SDSNH 64804–30, LACM 132488. *Xantusia henshawi henshawi* Riverside County: SDSNH 10872–76, 23364, 23367, 31517–18, 31571–614, 34740–61, 38042, 62304. San Diego County:

SDSNH 13368–70, 18484, 18505–06, 18653, 18639, 19039, 26891, 35495, 36347, 39371–73, 39421–26, 39911–12, 40206, 41002–03, 41090. Imperial County: SDSNH 20021, 23695, 26826–27, 49882, 57398–401, 57404, 57685–97, 57690–97, 58392–94, 59266–68, 59432, 60128–34.

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